Children’s Storybooks and Early Literacy in Rural Kenya: Evidence from 1.5 Randomized Evaluations

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Motivation

Investments in early childhood are critical to adult outcomes

Over 250 million children may not reach their developmental potential because of inadequate nutrition and stimulation in early childhood

- Inadequate stimulation during childhood impacts cognitive development, human capital, and income throughout adult life

Early childhood interventions can work, but they are often expensive

- Home visits by child development specialists (Gertler et al. 2014)

School-based interventions can be low-cost, but not always effective

- Many children do not attend preschool (Martinez et al. 2017)
- Difficult to improve school quality without engaging parents; they may have different objectives (Özler et al. 2018, Wolf et al. 2019)
Many ECD interventions rely on household members as mediators

- Many parenting interventions run counter to cultural norms, e.g. in Sub-Saharan Africa (Jukes et al. 2018, Weber et al. 2017)

Storybooks are a nudge reminding parents to stimulate children

- Only 3 percent of African children have at least 3 storybooks (MICS)
- Mother tongue children’s storybooks are almost never available
- Many parents do not realize importance of reading to children who have not started school and are not yet learning to read
**Motivation**

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**How can we encourage parents to read with young children?**

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Children’s Storybooks and Early Literacy
Encouraging Multilingual Early Reading as the Groundwork for Education

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Storybooks are a fundamental technology for building pre-literacy skills

- Reading with preschool-aged children is uncommon in many LMICs
- Introducing parents to **dialogic reading** approach may improve both quantity and quality of shared reading, making it more interactive
- Reading — particularly dialogic reading — have been shown to improve children's vocabulary (mostly in high-income countries)
- Can a light-touch intervention change household (reading) behavior?
The EMERGE Project

2014
- Development of the EMERGE intervention
  - Development of locally-appropriate storybooks for young children
  - Adaptation of modified dialogic reading training for caregivers

2015
- Adaptation, validation of appropriate measures of child development

2016
- Within-village randomized trial to estimate short-term impacts
  - 350 households assigned to treatment arms varying in intensity

2017
- Cluster-randomized trial in 73 communities
  - Census of all young children in 73 rural communities
  - Baseline survey of approximately 2,500 children aged 3–6

2018
- Intervention delivered in 36 randomly-selected communities
  - Midline survey of random subset of children and households

2019
- Endline survey of caregivers, sample children, and siblings

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Overview of the Talk

1. Development of the EMERGE intervention
2. Within-village pilot study documenting short-term impacts
3. Design of the cluster-randomized evaluation
4. Short-term impacts on shared reading
5. Measuring impacts at endline
6. Pre-analysis plan
Intervention Design
The EMERGE Project

We create **local-language storybooks** appropriate for young children

- Adapt locally-appropriate English-language illustrated storybooks
- Translate into Luo language, the mother tongue of study children

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The EMERGE Project

We develop a modified **dialogic reading** training for primary caregivers

- Adapted from dialogic reading interventions in Bangladesh (Aboud et al. 2009) and South Africa (Murray et al. 2016, Vally et al. 2015)

- Highlights critical importance of engaging young children in book-centered conversations (not just reading “to” them)

- Empowers illiterate caregivers to use books to stimulate a dialogue
Pilot Study
Existing evidence: dialogic reading improved child vocabulary in HICs, or when teachers/childcare providers in LMICs are trained (Mol et al. 2008)

- Study by Vally et al. (2015) finds positive effects of modified dialogic reading for mothers on young toddlers in South Africa

- Existing literacy interventions in SSA focus on school-age children
Evaluating the Short-Term Impacts of EMERGE

Existing evidence: dialogic reading improved child vocabulary in HICs, or when teachers/childcare providers in LMICs are trained (Mol et al. 2008)

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EMERGE intervention is (was) new, largely untested

- Do households value, use (local language) children’s storybooks?
- Does our modified dialogic reading program change behavior?
- Do children learn new vocabulary words from the storybooks?
- What is the optimal training intensity? Is training necessary?
Within-community pilot study estimates short-term impacts of EMERGE

- Partially addresses concerns about (within-community) spillovers
- Parallels existing literature on dialogic reading in LMICs

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Evaluating the Short-Term Impacts of EMERGE

randomly assign 357 caregivers in 9 rural communities

control

children’s storybooks

storybooks, dialogic reading training

storybooks, dialogic reading training, add’l booster

storybooks, dialogic reading training, add’l booster, home visit
Short-Term Impacts on Home Literacy Environment

- **T1**: Storybooks only
- **T2**: Storybooks and dialogic reading training
- **T3**: All of above plus booster training session
- **T4**: All of above plus home visit from dialogic reading trainer

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All treatments increase (self-reported) likelihood of reading with child

- Dialogic reading training increases likelihood caregiver herself reports reading with child, and likelihood of shared reading almost every day

- In treatment arms, almost all households report some shared reading (control group mean in left panel of figure is 70 percent)
Short-Term Impacts on Familiarity with Stories

We developed an objective measure of children's use of storybooks: 12 comprehension questions that children would be unlikely to guess

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Short-Term Impacts on Familiarity with Stories

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Short-Term Impacts on Familiarity with Stories

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Measure reading quality using **Mother Child Picture Observation** tool

- Caregivers demonstrate reading (a new book) with a child
- Enumerators code types of reading activities every 20 seconds
Short-Term Impacts on Storybook Vocabulary

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Heterogeneity by Caregiver Literacy

- Storybook vocabulary
- Mother focused on reading
- Dialogic reading behaviors
- Storybook comprehension
- Caregiver reading frequency
- Someone read to child in last 3 days

Estimated treatment effects

- Impact on illiterate caregivers
- Impact on literate caregivers
- Baseline gap: literate vs. illiterate

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Delivering books increased book-sharing in this context

- Large impacts of treatment on (self-reported) likelihood of reading with your child, children’s comprehension of storybook content
- Training for parents does not have any additional impact (here)

Dialogic reading training improves quantity, quality of reading

- Positive impacts on reading frequency (times per week)
- Positive impacts on quality of caregiver-child reading interactions
- Positive impacts on storybook vocabulary words

Booster training, home visits did not appear to increase impacts
Cluster-Randomized Evaluation
Main study is a cluster-randomized trial in 73 rural communities

- Baseline sample frame includes all households with children aged 36 to 83 months living within 750 meters of a focal primary school
Research Design

Sample frame

Communities assessed (n=88)

Communities excluded (n=15)
- Too few eligible caregivers (n=6)
- Communities used in piloting (n=4)
- Hostility toward survey team (n=4)
- Majority did not speak Luo (n=1)

Communities in sample (n=73)
- 2,013 caregivers
- 2,527 children

Community-level randomization

Randomize communities

Control communities (n=37)
- 997 caregivers
- 1,260 children aged 3–6
- 1,560 children aged 7–13

Treatment communities (n=36)
- 1,016 caregivers
- 1,267 children aged 3–6
- 1,551 children aged 7–13

Caregiver-level randomization

Randomize caregivers

Luo books
- 508 caregivers
- 635 children aged 3–6
- 765 children aged 7–13

English books
- 508 caregivers
- 632 children aged 3–6
- 786 children aged 7–13

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February and April of 2018: delivered treatment to 36 communities

- 88 percent of households sent at least one adult to the training
- We distributed storybooks to a further 78 households, so 95 percent of children in treatment communities received the EMERGE books
Short-Term Impacts at Midline
We report intent-to-treat estimates of (pooled) EMERGE treatment:

\[ Y_{ic} = \alpha + \beta EMERGE_c + \lambda_i + \delta_c + \varepsilon_{ic} \]

where:

- \( Y_{ic} \) is an outcome of interest for child \( i \) in community \( c \)
- \( EMERGE_c \) is an indicator for (community-level) treatment
- \( \lambda_i \) is a vector of age fixed effects
- \( \delta_c \) is a vector of stratum fixed effects
- \( \varepsilon_{ic} \) is a conditionally mean-zero error term

Midline survey: random sample of 300 children/households
Result 1: the intervention improved the home literacy environment

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Result 2: the intervention increased the quantity of book-sharing

Frequency of Book-Sharing

<table>
<thead>
<tr>
<th>Days</th>
<th>Control</th>
<th>Luo storybooks</th>
<th>English storybooks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 days</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>1 day</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
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<tr>
<td>2-3 days</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
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<tr>
<td>4-6 days</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Everyday</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

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Result 3: the intervention increased the quality of book-sharing

We measure the quality of caregiver-child book-sharing activities through the **Mother Child Picture Observation** Assessment

- Caregivers provided with an unfamiliar storybook
- Enumerators observe caregiver reading with her child
- Behaviors coded in 20-second intervals:
  - Traditional (i.e. “non-interactive”) reading
  - Dialogic reading
  - Other behaviors (e.g. scolding the child)
Result 3: the intervention increased the quality of book-sharing.

- Reading to the child (2.0)
- Naming or describing objects (8.3)
- Asking child questions (11.5)
- Answering child's questions (0.1)
- Expanding on what child says (0.9)
- Asking child to expand (5.0)
- Listening to child (9.0)
- Encouraging child (0.5)
- Scolding child (0.8)
- Distracted or off task (3.8)

Treatment effect (on periods observed, out of 20)

Non-interactive behaviors
Dialogic reading behaviors
Unconstructive behaviors
Result 4: children use the EMERGE books and learn the stories

We developed a series of comprehension questions that children would be unlikely to guess (e.g. “Where is Ben going?” or “Why is Ben sad?”)

⇒ Provides an objective measure of use of storybooks
Short-Term Impacts

Result 4: children use the EMERGE books and learn the stories

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Result 5: other women and girls also read the storybooks

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Measuring Impacts at Endline
Measuring Vocabulary

“Show me the DOG”

“What is this?”

Receptive Vocabulary
Expressive Vocabulary

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Measuring Vocabulary

Graph showing the expressive vocabulary responses in Luo, Swahili, and English across different child age ranges (24-35, 36-47, 48-59, 60-71, 72-83 months). The graph indicates a decrease in Luo and Swahili responses and an increase in English responses as children grow older.

Source: Knauer et al. (2019)
Measuring Vocabulary

Inherent tension in measuring child development in LMIC settings

- Well-validated, widely used measures designed for HIC contexts
- May not capture child development in very different contexts

Source: British Picture Vocabulary Scale (Dunn, Dunn, and Styles 2009)
Measuring Vocabulary

“banister”

“drinking”

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Measuring Vocabulary

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Measuring Vocabulary

Objective measures of item performance:

- Correlation with child age
- Correlation with total score, leave-one-out sum
- IRT estimate of item discrimination
  - Discrimination may appear low for very easy/difficult items
Measuring Vocabulary

Objective measures of item performance:

- Correlation with child age
- Correlation with total score, leave-one-out sum
- IRT estimate of item discrimination
  - Discrimination may appear low for very easy/difficult items

Why retain items that perform poorly?

- Not clear what it means to have comparable items when items do not have the same psychometric properties in different contexts
- We would not use English-language items in francophone countries
- Items that do not capture child development reduce statistical power
Measuring Vocabulary

We adapt and extend the British Picture Vocabulary Scale (BVPS) to create English and Luo receptive vocabulary tests (Knauer et al. 2019)

- Adapt (seemingly) locally-appropriate items from BPVS
- Work with Kenyan artists to develop new, similarly-structured items
- Pilot all items with Kenyan schoolchildren, retaining those with reasonable psychometric properties while ensuring range of difficulty
We develop a new, locally-appropriate expressive vocabulary assessment

- Existing tests relied on many inappropriate stimuli
- Use pilot data to characterize correct and common incorrect responses in all local languages to maximize inter-rater reliability
Measuring Vocabulary

Source: baseline data from EMERGE cluster-randomized evaluation

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Measuring Other Outcomes

Child assessments:

- Early literacy assessment (EGRA) in both English and Luo
- Child activities/time use (through both parent and child reports)

Primary caregiver survey:

- Shared reading and early childhood stimulation (expanded FCI)
- Women’s time use (home production, childcare, leisure, etc.)
- Beliefs about children’s vocabulary skills
- Demand for storybooks

Classroom observation, abbreviated teacher survey
Pre-Analysis Plan
Primary and Secondary Hypotheses

Primary hypothesis: EMERGE improved children’s vocabulary, literacy

- Which types of vocabulary?
- Vocabulary, literacy in which language?
- Which children will be (measurably) impacted?
- Does the language of the storybook matter?
Primary and Secondary Hypotheses

Impacts on child vocabulary, literacy?

- No
  - Interpret null result

- Yes
  - Understand mechanisms

Impacts on HH behavior?
Primary and Secondary Hypotheses

Impacts on child vocabulary, literacy?

- Yes
  - Understand mechanisms
- No
  - Interpret null result

Impacts on HH behavior?

Secondary research questions:

- Are treated HHs reading more one year after treatment?
- Do children, siblings, parents know the stories?
- Do HHs engage in more child stimulation overall?
- Who does the stimulation, and what do they substitute away from?

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Measuring Impacts on Vocabulary

\[
\text{MDE} = (t_{1-\kappa} + t_{\alpha/2}) \cdot \sqrt{\frac{1}{P(1-P)}} \cdot \sqrt{\frac{1}{N}} \cdot \sigma \cdot \sqrt{1 + (n_{\text{groupsize}} - 1)\rho}
\]

Usually \(\approx 2.8\)  
Fixed given research design

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Measuring Impacts on Vocabulary

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- Assumption (baseline data)
Measuring Impacts on Vocabulary

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Usually \( \approx 2.8 \)  
Fixed given research design  
Assumption (baseline data)

**English receptive vocabulary:**

Data from EMERGE pilot suggest \( \rho \approx 0.026 \)

\[ \text{MDE} \approx 0.153\sigma \]

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*Children's Storybooks and Early Literacy*
Measuring Impacts on Vocabulary

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Coef.</th>
<th>S.E.</th>
<th>P-Val.</th>
<th>95% CI</th>
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</thead>
<tbody>
<tr>
<td>Storybook Expressive</td>
<td>0.240</td>
<td>0.113</td>
<td>0.036</td>
<td>[0.016, 0.463]</td>
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<tr>
<td>Non-Storybook Expressive</td>
<td>0.041</td>
<td>0.107</td>
<td>0.703</td>
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<tr>
<td>Luo Receptive Vocabulary</td>
<td>0.022</td>
<td>0.139</td>
<td>0.869</td>
<td>[-0.242, 0.286]</td>
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<tr>
<td>English Receptive Vocabulary</td>
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<td>0.276</td>
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<tr>
<td>Vocabulary Index</td>
<td>0.113</td>
<td>0.067</td>
<td>0.096</td>
<td>[-0.020, 0.246]</td>
</tr>
</tbody>
</table>

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Measuring Impacts on Vocabulary

\[
\text{MDE} = \left( t_{1-\kappa} + t_{\alpha/2} \right) \cdot \sqrt{\frac{1}{P(1-P)}} \cdot \sqrt{\frac{1}{N}} \cdot \tilde{\sigma} \cdot \sqrt{1 + \left( n_{\text{groupsize}} - 1 \right) \tilde{\rho}}
\]

Use a one-sided test
(Anderson and Magruder 2017)

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Measuring Impacts on Vocabulary

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- Use a one-sided test
- Control for baseline \( Y \), use residuals (calculated in pilot data)

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Measuring Impacts on Vocabulary

\[ \text{MDE} = (t_{1-\kappa} + t_{\alpha}/2) \cdot \sqrt{\frac{1}{P(1-P)}} \cdot \sqrt{\frac{1}{N}} \cdot \tilde{\sigma} \cdot \sqrt{1 + (n_{\text{group size}} - 1)\tilde{\rho}} \]

- Use a one-sided test
- Control for baseline \( Y \), use residuals (calculated in pilot data)

**English receptive vocabulary:**

Data from EMERGE pilot suggest \( \tilde{\sigma} \approx 0.888, \tilde{\rho} \approx 0.005 \)

\[ \text{MDE} \approx 0.095\sigma \]

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## Measuring Impacts on Vocabulary

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unadjusted</th>
<th>Covariate-Adjusted</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$\rho$</td>
<td>MDE</td>
<td>$\tilde{\sigma}$</td>
</tr>
<tr>
<td>Storybook Expressive</td>
<td>0.076</td>
<td>0.187</td>
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<tr>
<td>Non-Storybook Expressive</td>
<td>0.050</td>
<td>0.163</td>
<td>0.656</td>
</tr>
<tr>
<td>Luo Receptive</td>
<td>0.016</td>
<td>0.124</td>
<td>0.774</td>
</tr>
<tr>
<td>English Receptive</td>
<td>0.026</td>
<td>0.136</td>
<td>0.888</td>
</tr>
<tr>
<td>Vocabulary Index</td>
<td>0.060</td>
<td>0.172</td>
<td>0.606</td>
</tr>
</tbody>
</table>
Measuring Impacts on Vocabulary

We are well-powered to detect small effects, estimate precise nulls

- Baseline data available for all vocabulary outcomes
  - Child assessments are highly correlated over time
  - Measures were age-appropriate at baseline and endline
  - Intra-class correlation lower for residualized outcomes
- EMERGE pilot data, existing literature suggest positive impacts
  - Pre-analysis plan allows credible commitment to one-sided test
- Four (vocabulary) outcomes of interest
  - Pilot suggests largest impacts on English receptive vocabulary, existing literature suggests biggest impacts on expressive vocabulary
  - Focus on aggregate vocabulary index, adjust individual vocabulary outcomes for multiple hypothesis testing following Anderson (2008)
Measuring Impacts on Early Literacy

Baseline data on early literacy extremely limited

• EGRA not appropriate for preschool-aged children

• Predictive power of baseline covariates (for EGRA) unknown
  ▶ Knowledge of letters, familiar word reading, vocabulary
Baseline data on early literacy extremely limited

- EGRA not appropriate for preschool-aged children
- Predictive power of baseline covariates (for EGRA) unknown
  - Knowledge of letters, familiar word reading, vocabulary

EGRA is appropriate for older children; we are measuring 2,043 of them

- Does increasing sample size by adding older siblings for whom baseline data is unavailable increase our statistical power?
Measuring Impacts on Early Literacy

Calculate MDE for baseline only sample, baseline+siblings sample

\[
MDE = (t_{1-\kappa} + t_{\alpha/2}) \cdot \sqrt{\frac{1}{P(1-P)}} \cdot \sqrt{\frac{1}{N}} \cdot \sigma \cdot \sqrt{1 + \left(\frac{n_{\text{groupsize}}}{N} - 1\right) \rho}
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Calculate MDE for baseline only sample, baseline+siblings sample

$$MDE = (t_{1-\kappa} + t_{\alpha/2}) \cdot \sqrt{\frac{1}{P(1-P)}} \cdot \sqrt{\frac{1}{N}} \cdot \sigma \cdot \sqrt{1 + \left(\frac{n_{\text{groupsize}}}{\rho} - 1\right)}$$

Commit (through PAP) to using estimation strategy with smaller MDE

<table>
<thead>
<tr>
<th>Sample</th>
<th>$N$</th>
<th>$\tilde{\sigma}$</th>
<th>$\tilde{\rho}$</th>
<th>MDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline sample</td>
<td>2,527</td>
<td>1</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Baseline sample plus older siblings</td>
<td>4,570</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>
Calculate MDE for baseline only sample, baseline+siblings sample

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</tbody>
</table>

Use LASSO to identify relevant baseline covariates from restricted subset

- Use different covariates to predict different outcomes w/o p-hacking

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Secondary Hypotheses

- Differential impact by storybook language
  - Does language impact proficiency in English vs. Luo?
- Impacts on shared reading behaviors, stimulating activities
  - Number of children’s storybooks in the home
  - Frequency of shared reading
  - Do young children, older siblings, adult caregivers know stories?
  - Overall level of early childhood stimulation
  - Demand for children’s storybooks, beliefs about child ability
- Impacts on literacy, time use by mothers, older siblings
- Heterogeneity by child age, caregiver literacy, other covariates (ML)
Next Steps
Next Steps

EMERGE team will deliver intervention to all communities in early 2020

- Building a model for scale-up, if intervention proves effective
- Evaluate messaging designed to encourage fathers to attend training
- Show appreciation to communities involved in our research

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Thank you for listening!